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scope, found the bright star to be a close double. He also secured one measure in the following year. In 1890 and 1891 the star appeared round to BURNHAM when he examined it with the 36-inch telescope under good conditions, but in 1899 SEE found it an easy pair to measure with the 26-inch at Washington, and I have measured it every year since then with the 36-inch telescope. My last measures give:—

1904.96	12°.8	0″.12	2^n

The companion has apparently described an arc of nearly 300° since its discovery by HOUGH in 1886, and it is evident that the revolution period will be very short—certainly less than twenty-five years. It would not be difficult to construct an orbit that would represent all the observations so far made and that would also satisfy the condition that the apparent separation of the two components must be assumed to be very small in 1877 and in 1890 and 1891, when BURNHAM failed to see the star double. Such an orbit would probably define the revolution period, the inclination, and some of the other elements with a fair degree of accuracy, but others, and especially the eccentricity, would be very uncertain, depending almost wholly on HOUGH'S estimates (not measures) of distance on two nights only. It will be more satisfactory to wait a few years until further measures have supplied data for an accurate orbit.

R. G. AITKEN.

January 25, 1905.

NORMAL PLACES OF THE *EROS* REFERENCE-STARS.

Since the inauguration of the work of determining the solar parallax from observations upon the planet *Eros*, the discussions in current astronomical literature as to the proper combination and use of observations have been very extensive. Not the least among the points of controversy has been the proper use of the meridian-circle observations employed.

To those who have been noting the progress of the *Eros* work it will be a source of gratification to learn that the stars observed by the meridian-circle have been reduced to a normal system which will be used without further discussion by those employed on the *Eros* work. The catalogue of the normal places is published in Circular No. 11 of the Conférence Photographique Internationale. The reduction was made by Mr. R. H. TUCKER, of the Lick Observatory, and a brief outline of the method employed is here given. The two lists of *Eros* stars were observed with greater or less completeness at thirteen widely-separated observatories, the names of which are given in a table at the end of this article. As was anticipated, small systematic differences were found in the resulting star places as published by the separate observatories, and it has been the aim of Mr. TUCKER, in the above publication, so to combine the separate results as to obtain the most probable value of the definite position of each star.

As is well known, these stars are to be used to obtain the positions of *Eros*, from the plates upon which it has been photographed. If the field of the photograph is large enough to include a sufficient number of these stars for determining the plate constants and scale value, the position of *Eros* may be at once derived. But if the field is small, and there are but few if any of these reference-stars found upon it, recourse must be had to the fainter stars which it contains. The positions of these faint stars are derived from photographs taken for the purpose, containing the faint stars and stars of the present normal system to be used as reference-points.

The first step in the reduction was to find the difference in Right Ascension and Declination between each star of the Lick Observatory list and the Right Ascension and Declination of the same star as given in each of the other lists. Any complete list would have served the same purpose; but the Lick Observatory list has been chosen on account of its uniformity and completeness. The resulting comparison gave twelve series of results, each containing as many differences as there were stars common to the two lists compared. As every star of the *Eros* lists was observed at the Lick Observatory, all the material that each list furnishes for deriving suitable corrections to reduce to a normal system is contained in these twelve series.

The mean of each series of residuals is now taken. These mean differences represent the corrections which must be applied to each list in order to reduce them to the Lick Observatory system. To derive the correction which must be applied to the Lick Observatory list the weighted mean of the twelve mean differences. indicated above, is taken with contrary sign.

This correction to Lick Observatory is applied to each mean difference, and the result is the correction for each list, necessary to reduce it to the weighted mean of all the lists.

The range in Right Ascension of the first list is small, and there is no evidence of a rate in the Right Ascension or Declination corrections corresponding to a change in Right Ascension. The range in Declination is comparatively large, however, and an investigation was made of the rate in the Right Ascension and Declination corrections, corresponding to changes in Declination. Thirty stars of the lowest Declination (38°.1 to 41°.3) and thirty of the highest (54°.1 to 55°.4) have been separately compared, for deriving the rates for the first list. Since the groups thus compared differ less than five minutes in Right Ascension, the rates derived should be mainly due to the Declination factor. The corrections derived in the manner indicated above, together with the rates here obtained for them, are tabulated in tables IV and V of the publication.

These corrections having been applied to the coordinates of the respective lists, the weighted mean of the Right Ascension and Declination as furnished by these corrected lists is taken. This weighted mean furnishes the final definitive position as published in the catalogue.

In the first list there are in Right Ascension about 8,500 observations included; in Declination about 7,000, giving an average per star of 26 and 22 respectively. In the second list there are 10,640 observations in Right Ascension, and 9,140 in Declination, giving averages respectively of 30 and 26 per star.

The probable error of the separate determinations have been computed from the residuals of the corrected results, compared with the weighted mean. For weight unity the probable errors are found to be $\pm 0^{s}.045$ and $\pm 0''.38$ in the first *Eros* list. Since the total of the weights assigned would give an average of 22 per star in Right Ascension and 19 in Declination, the probable errors of the catalogue place would be $\pm 0^{s}.009$ and $\pm 0''.09$ respectively. In the second list, for the average weight, the probable errors of a place are found to be $\pm 0^{s}.007$ and $\pm 0''.09$.

Preceding each of the two lists is a table giving the probable errors of the separate determinations, by observatories, together with the average number of observations upon which a determination depends. The probable error of a final position, as given above, will be the only one with which those who use these stars will be concerned. It is a source of no little interest, however, to see a comparative statement of the probable error of a single observation, as made at the separate observatories.

From a well-known least-square theorem, the probable error of one determination is obtained by dividing the probable error of the mean of several by the square root of the number included in the mean. Using this method, I have obtained from these tables the probable error of one observation for each observatory in the list. Each of the two tables will give a determination; and below is given the mean probable error of one observation, as determined from the two tables, the Right Ascension error being first transformed into seconds of arc.

	R. A.	Decl.
Abaddia (Italy)	± 0″.40	± 0″.41
Greenwich	.57	.45
Kœnigsberg	.51	..
Lick	.31	.28
Lisbon	.34	.35
Marseilles	.69	.42
Nice	.57	.43
Paris	.60	.47
Rome	.97	.88
San Fernando (Spain)	.84	.56
Strassburg	.33	.40
Toulouse	.57	.36
Washington	.43	.55

The Kœnigsberg Right Ascensions and Declinations were observed separately and the observations in Declination have not yet been published.

The probable error as given for Rome depends upon the first list, only a small number of stars of the second list having been observed there.

The two lists were observed at Washington with different instruments. The observations in Declination made with the old instrument are found to be more accurate and reliable than those made with the new one.

ELLIOTT SMITH.

January, 1905.

ADDITIONS TO THE LICK OBSERVATORY RESERVATION.

The Regents of the University of California have recently added to the Lick Observatory Reservation, by purchase, two hundred and forty acres of land, as follows:—

Eighty acres near the northeast corner of the Reservation (Holden tract); one hundred and sixty acres on the western edge of the Reservation, one hundred and twenty acres of which projected within the general western boundary-line (Cook tract).

The Reservation has been formed, as follows:—

By Congressional Grant (original)	1345.80 acres
By Congressional Grant (second)	599.94
By California State Grant	320
By Gift, Robert F. Morrow	40
By Purchase	191.49
By Purchase	40
By Purchase	80
By Purchase	160
Total	2777.23 acres

W. W. Campbell.